Cosmology constrains on LDM

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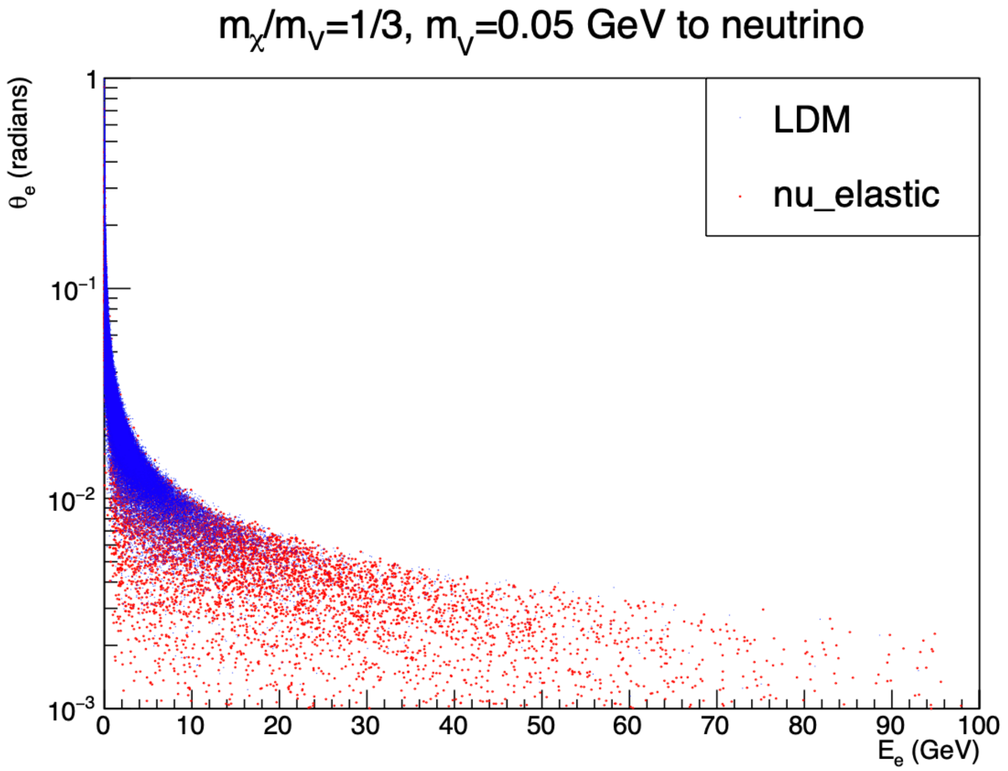
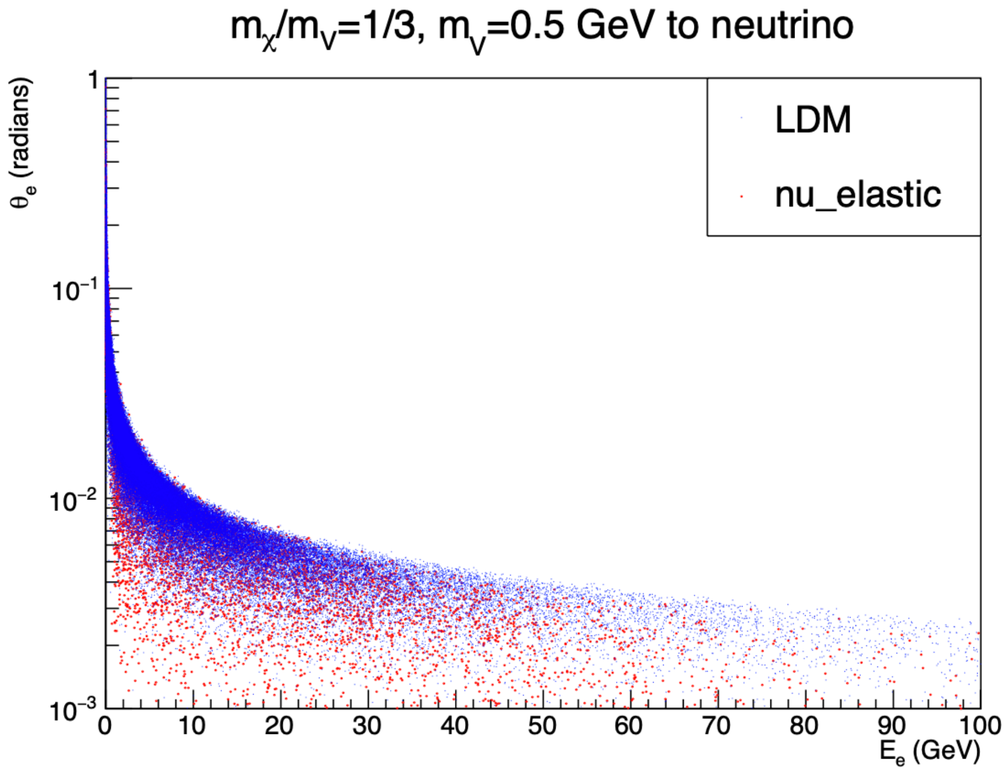
GOAL: differentiate Light Dark Matter (LDM) interactions from neutrino-induced events





- Todays talk focus on:
  - LDM production via different mechanisms
  - Analysis of event rates under varying mass and energy conditions
  - Consideration of cosmological constraints, specifically relic density

$$\sigma/\sqrt{E} \sim 30\%/\sqrt{E}$$

LDM Production Channels:

1609.01770

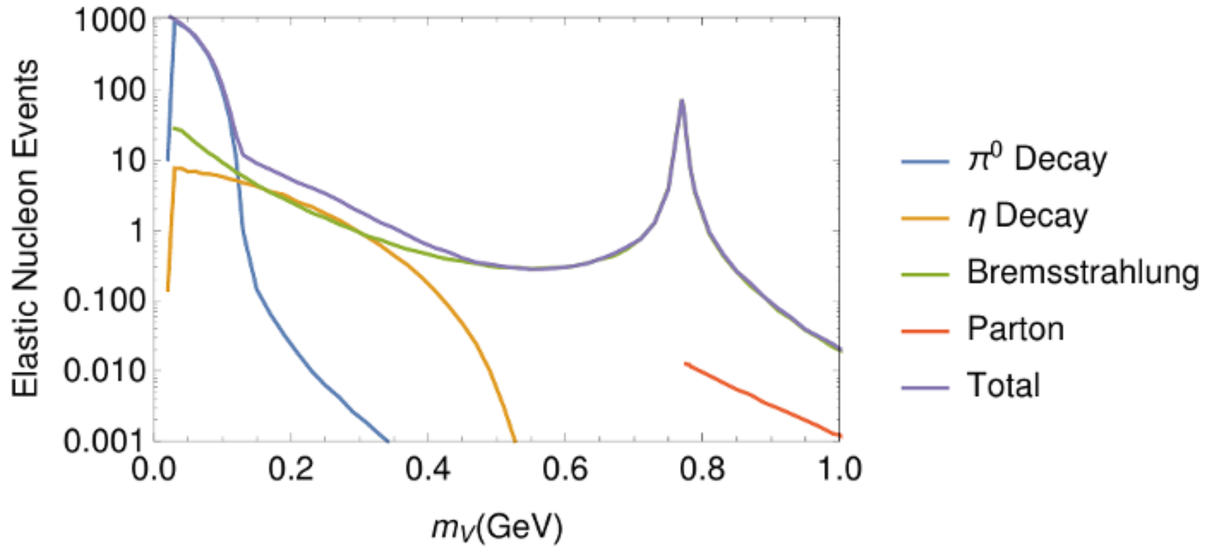


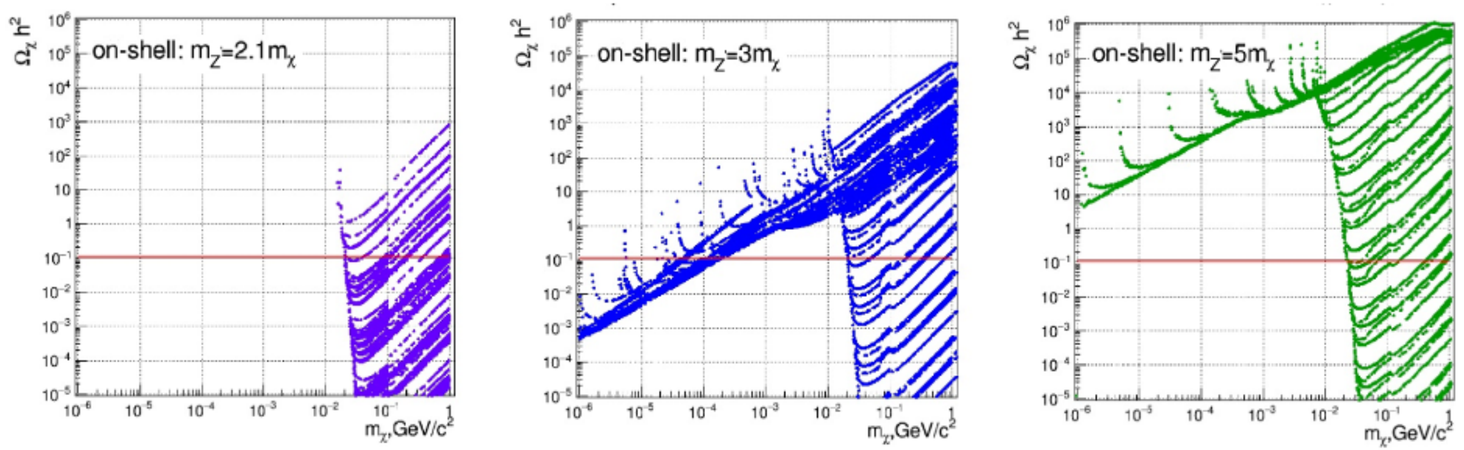
FIG. 1. A plot illustrating the distinct contributions to DM production (coupled through the vector portal), as discussed in the text, using the 9 GeV proton beam at MiniBooNE as an example. The rate of elastic scattering events on nucleons is plotted versus the vector mediator mass. From smaller to larger values of m_V, the dominant channels are π^0 decays, η decay, bremsstrahlung, which becomes resonant near the ρ/ω mass region, and finally direct parton-level production. The plot uses $m_\chi = 0.01$ GeV, $\epsilon = 10^{-3}$ and $\alpha' = 0.1$.

Dominant Channels by Mediator Mass:

- **Low Mass:**
  π^0 decay
- **Intermediate Mass**:
  η decay and Bremsstrahlung (Bremsstrahlung dominates in the intermediate mass range (~100 MeV and above).)
- **High Mass**:
  Bremsstrahlung

micrOMEGAs is used to assess models meeting relic density $\Omega h^2 \approx 0.11$

Dark matter abundance (Ωh^2) in on-shell regimes. The red lines indicate the area nearby $\Omega h^2 = 0.11$



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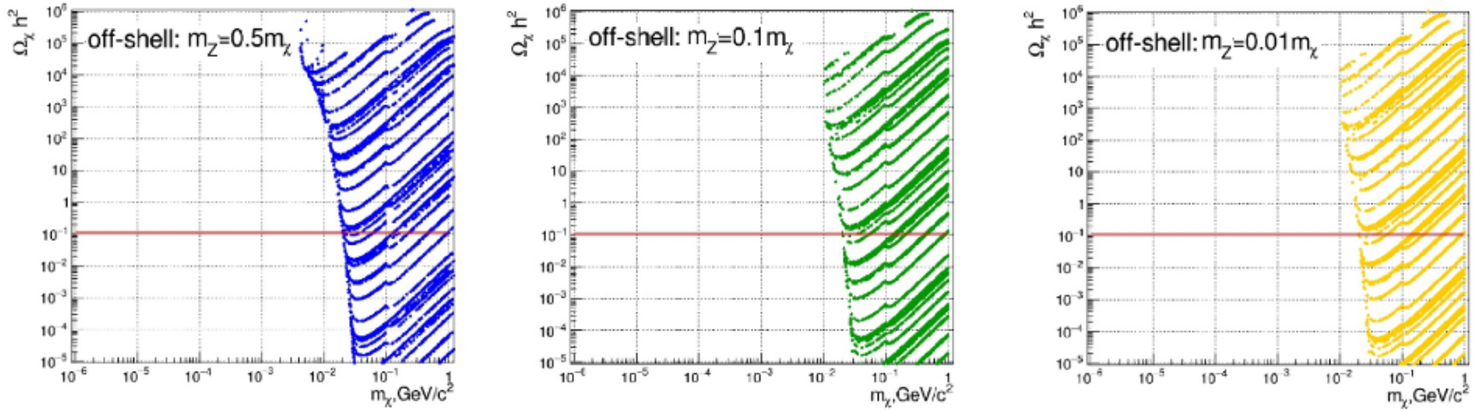


On-Shell Regime:

- Mediator mass $m_V > 2m_{DM}$
- Mediator can be a real particle.

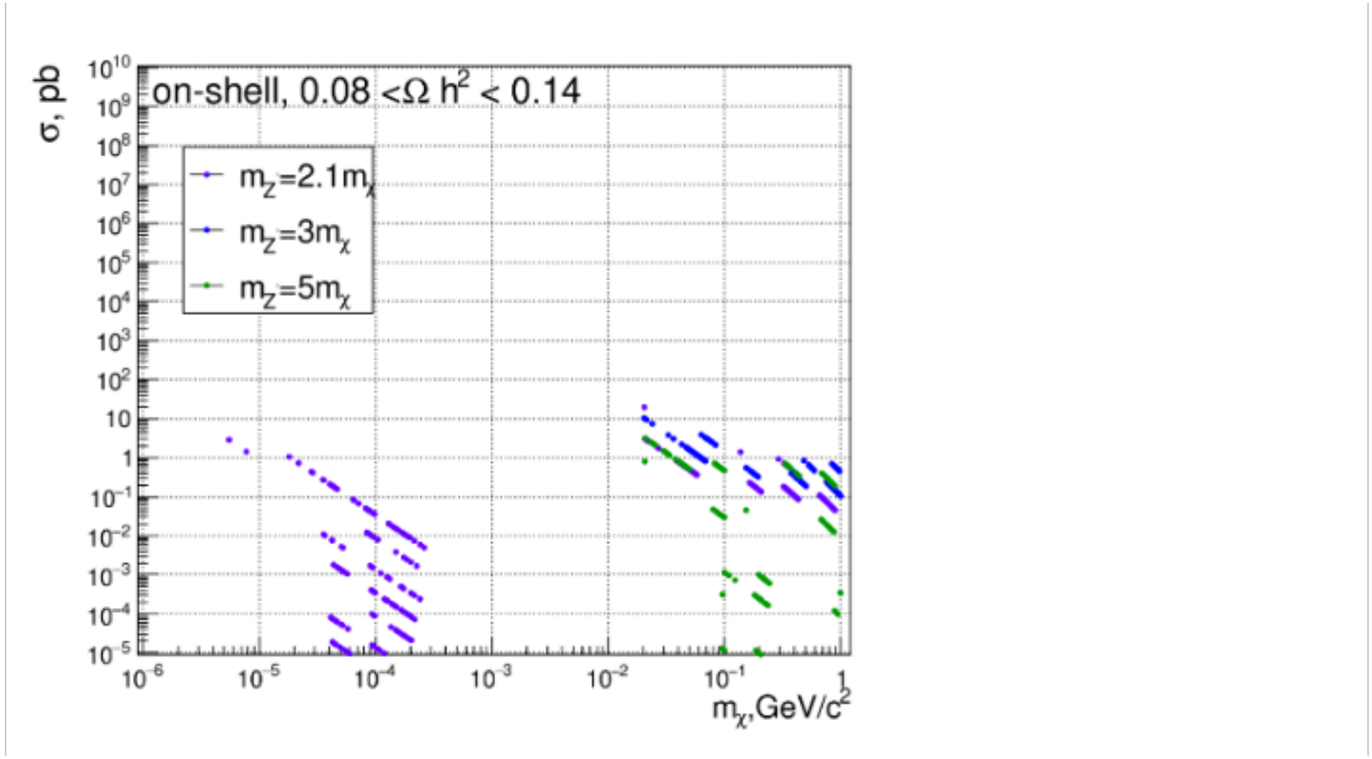
Off-Shell Regime:

- Mediator mass $m_V > 2m_{DM}$
- Mediator is virtual.

Cross-section:

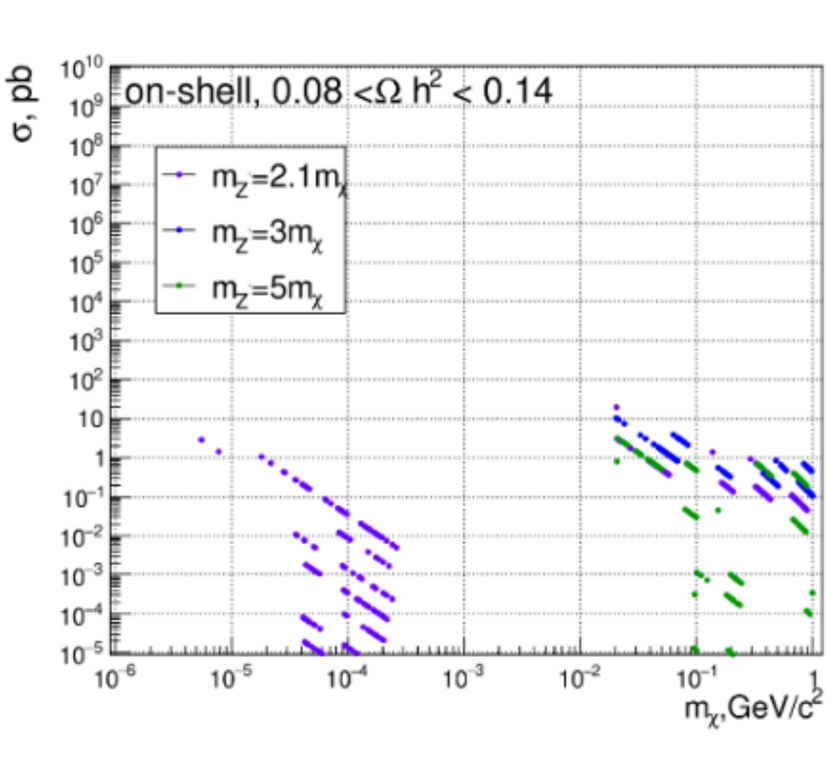
Choose model points where the calculated relic density (Ωh^2) is close to the observed value of 0.11.

!Ensures that selected DM models are consistent with cosmological observations of dark matter abundance in the universe.



On-shell regime.

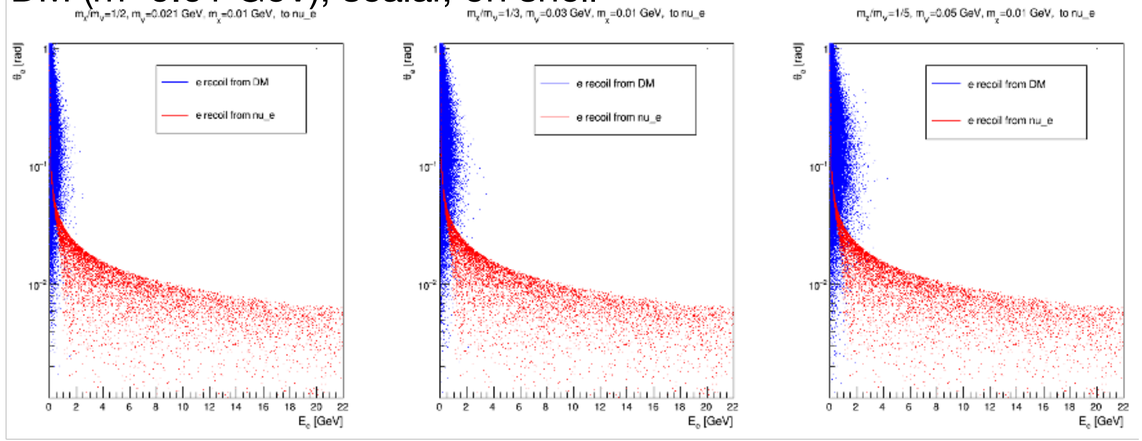
Quasi elastic cross section values for Z' model space parameters in the close vicinity of the Ωh^2 = 0.11



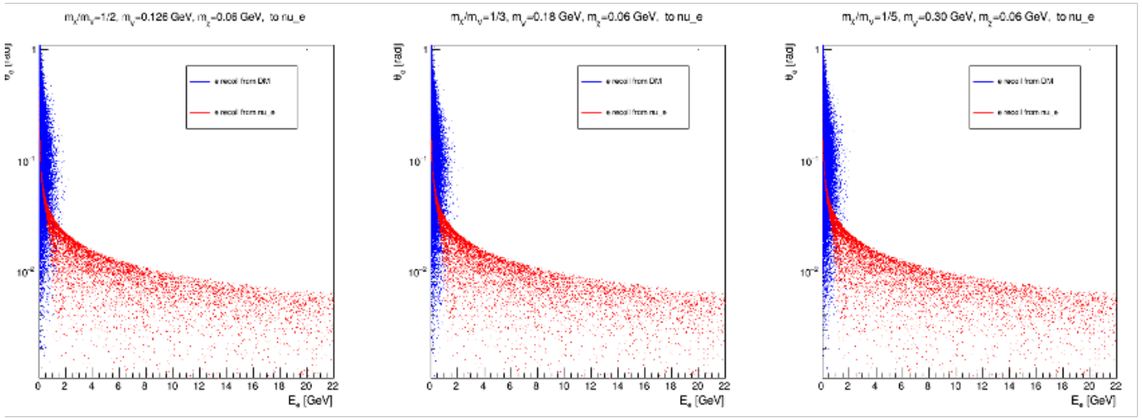
Off-shell regime.

Quasi elastic cross section values for Z' model space parameters in the close vicinity of the Ωh^2 = 0.11.

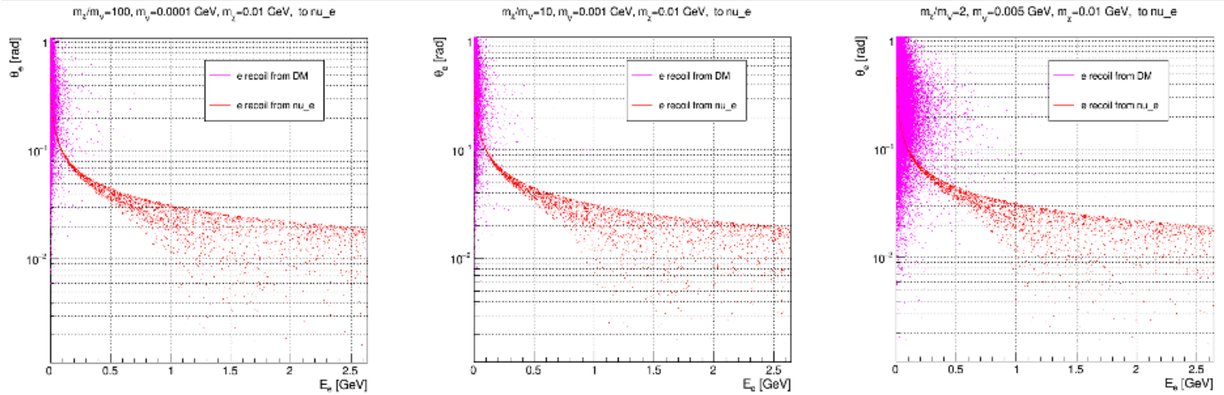
DM (m=0.01 GeV), scalar, on shell



DM (m=0.06 GeV), scalar, on shell



DM (m=0.01 GeV), scalar, off shell



π0 decay: Main channel for low mediator masses, effective for low-energy LDM detection.

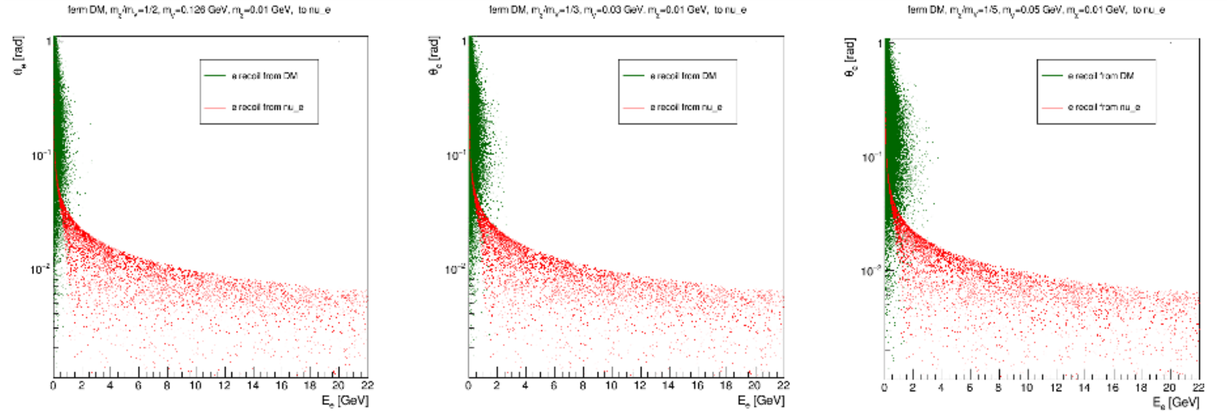
on shell
#dark_matter_mass 0.01 #dark_photon_mass 0.03
#dark_matter_mass 0.01 #dark_photon_mass 0.05
#dark_matter_mass 0.01 #dark_photon_mass 0.021

off shell
#dark_matter_mass 0.01 #dark_photon_mass 0.005
#dark_matter_mass 0.01 #dark_photon_mass 0.001
#dark_matter_mass 0.01 #dark_photon_mass 0.0001

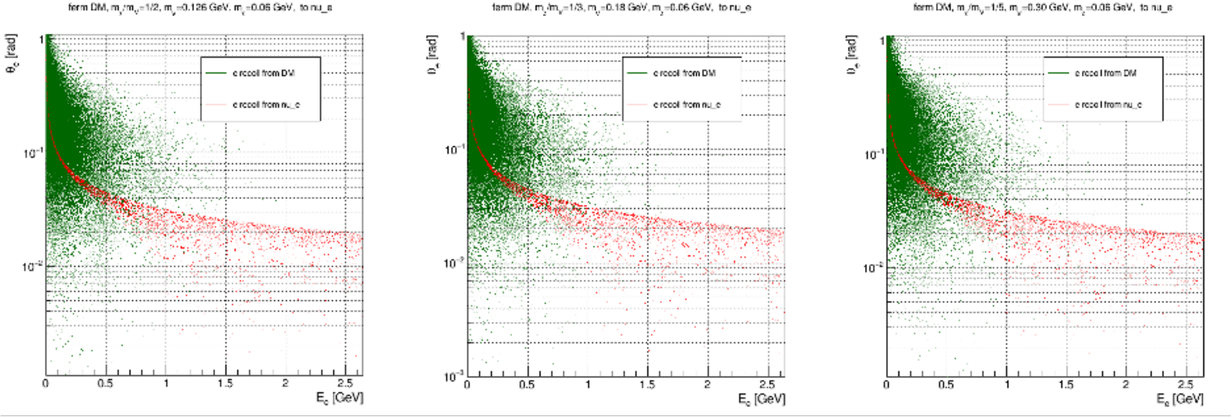
#dark_matter_mass 0.06 #dark_photon_mass 0.03
#dark_matter_mass 0.06 #dark_photon_mass 0.006
#dark_matter_mass 0.06 #dark_photon_mass 0.0006

Simulated mass ratios for scalar and fermionic DM, both on-shell and off-shell

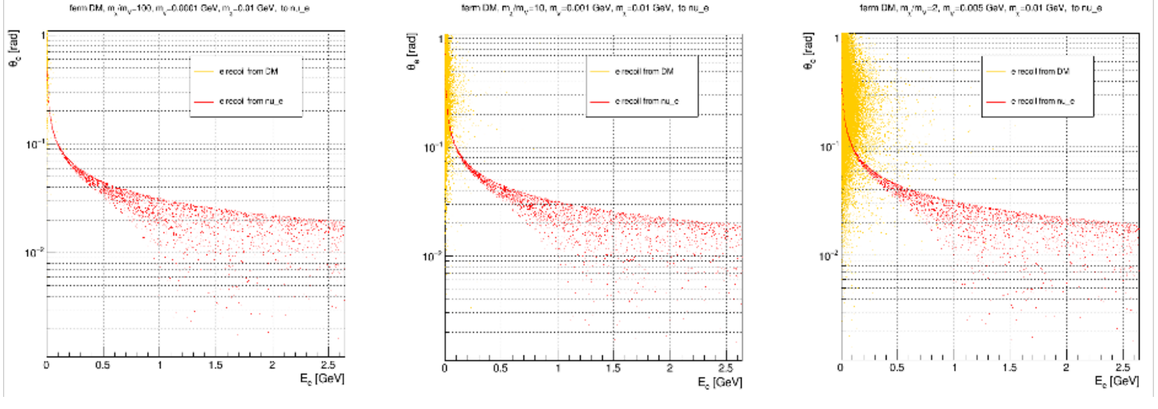
DM (m=0.01 GeV), fermion, on shell



DM (m=0.06 GeV), fermion, on shell



DM (m=0.01 GeV), scalar, off shell



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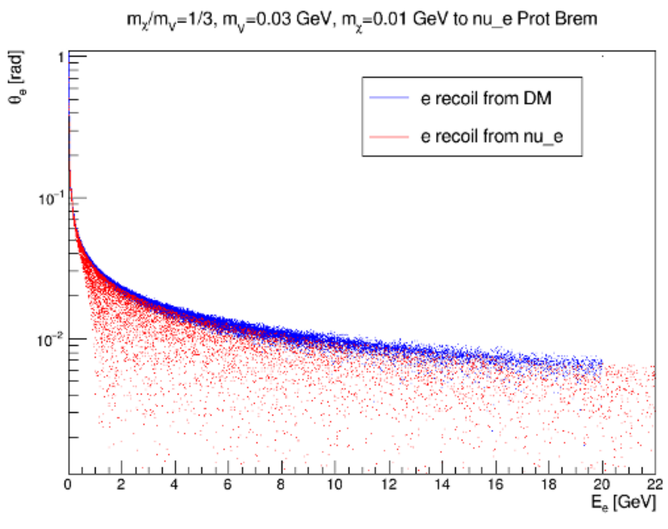
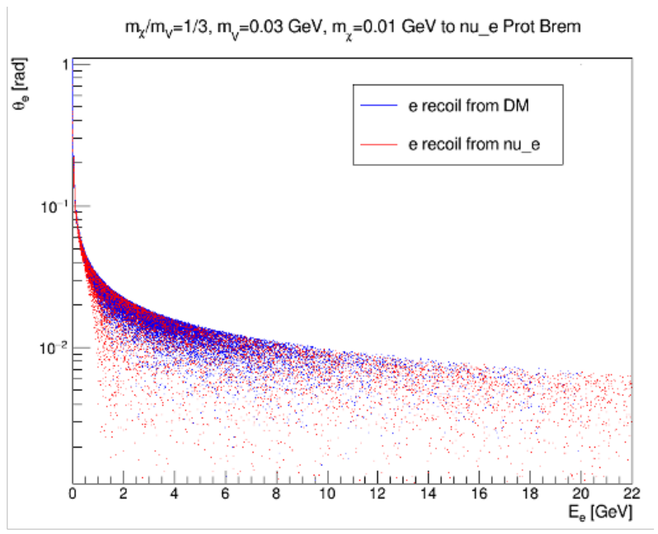
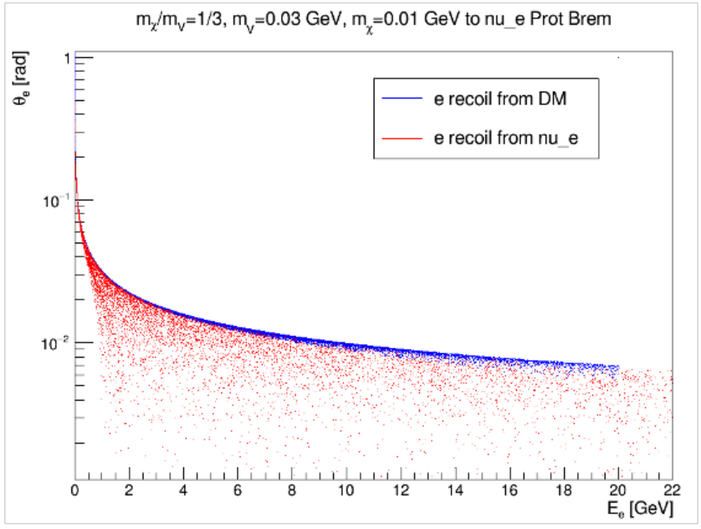


ptmax 0.2
zmin 0.3
zmax 0.7



ptmax 0.02
zmin 0.3
zmax 0.9



ptmax 0.02
zmin 0.8
zmax 0.9

ptmax: The maximum transverse momentum which a produced V mediator may possess. The minimum is assumed to be 0.

zmin: The minimum value of $z = \frac{p_{V,z}}{P}$, where $p_{V,z}$ is the momentum of the V parallel to the z axis, and P is the total momentum of a beam proton incident on the target. See below for further details on choosing these parameters.

zmax: The maximum value of z, defined as in the **zmin**.

For the proton bremsstrahlung channel, we examine how varying parameters such as pTmax , zmin , and zmax affect LDM distribution in the detector
(needs to be checked with Maksym)